Table 4-1. Helicopter Load Panning Data.

AIRCRAFT TYPE	COMBAT LOADED TROOPS	ADMIN TROOPS (PMC)	INTERNAL CARGO WEIGHT (lbs)	EXTERNAL CARGO WEIGHT (lbs)
CH-53E	24	37	15,000	36,000
CH-53D	24	37	8,000	24,000
UH-1N	06	08	1,400	1,400
CH-46	12	12	3,000	3,000
CH-47	31	31	50,000	25,000
SH-60	11	20	22,000	8,000
MV-22	24	24	20,000	15,000
Capabilities are for planning purposes only. Maximum internal or external load capabilities may be lower depending on weather conditions, aircraft fuel load, and limitations of specific aircraft type, model, and series.				

Planning for Wave, Beach, and Surf Conditions

Selecting Beaches

Within limits set by strategic and tactical considerations, landing areas should be selected with reference to surf and beach conditions under exposure to different wave conditions. After the hydrography of each area has been obtained, wave refraction diagrams should be drawn to show the variations in surf conditions along the beach for wave periods and deep-water directions over the entire possible range. Alternative landing plans for each landing area will be desirable if the analysis shows markedly different surf conditions under exposure to waves of different possible directions and periods.

Selecting Ships and Vehicles

Selecting ships and landing craft with relation to anticipated surf conditions should be completed during the early planning stage of an operation. It is possible to plan for surf at this stage only on a statistical basis, but the probability of light or heavy surf action at the time and place of the landing should also be considered. On shores noted for severe surf, there are some days of relative calm. On shores where the surf is normally light, there are usually some days of heavy surf.

Key information that should be obtained during the planning phase of a surfaceborne operation includes:

- Prevailing winds and surf.
- Refraction diagram and currents.
- Prevailing sea and swell tides.
- Beach slope and materials.
- Beach irregularities.

While the above information satisfies planning phase requirements, it does not meet the data requirements for D-Day. The following data is essential for D-Day operations. This information may be provided to planners by pre-assault forces using standardized reporting procedures.

- Surf and swell conditions.
- Depth of water and beach slope.
- Beach features (bars, troughs).
- Width of the surf zone.
- Significant breaker height.

- Angle of breakers to the beach.
- Wave length outside breaker line.
- Tides.
- Currents.
- State of the sea.
- Depth of breaking.
- Longshore currents.
- Period of breakers.

Surface Observation Reporting

Surf conditions are reported by various organizations. Usually SEALS, beachmasters or force reconnaissance personnel provide this information, depending upon the specific operation, since they are all trained to perform this task.

The observing force is required to observe 100 breakers (50 in a combat or hostile environment). Once this has been accomplished, the reporting unit uses the following format for a numbered beach on a given date and at local time.

INDEX	DESCRIPTION
ALFA	Significant breaker height: The average height of the one-third highest breaker on that beach.
BRAVO	Maximum breaker height: The highest breaker observed on that beach.
CHARLIE	Period of breaker: The time interval between breakers.
DELTA	Which is the type of breakers and percentage of each.
ECHO	Breaker angle: The acute angle, in degrees, that a breaker makes with the beach and its direction relative to the beach (right/left flank).
FOXTROT	Littoral current: The long shore currents direction and speed.
GOLF	The number of lines of breakers in and the width of the surf zone measured in feet.
HOTEL	Remarks: Information important to landing operations such as wind direction and velocity, visibility, debris in the surf zone, secondary wave system, dangerous conditions, etc.

The information provided by surf observation reports is processed accordingly (using modification tables) by the PCO. The final product is an abstract number called "MODIFIED SURF INDEX" that gives planners an idea of the feasibility of the landing for each different craft available.

Modified Surf Index

The modified surf index (MSI) is a single dimensionless number that provides a relative measure of the conditions likely to be encountered in the surf zone. For the reported or forecast conditions, the MSI provides a guide for judging the feasibility of landing operations for each type of landing craft. However, the MSI is not used for LCAC, rigid raiding craft, and combat rubber raiding craft.

Modified Surf Index Calculation

When applied to a known or forecasted surf condition, the modified surf index calculation provides the commander with an objective method of arriving at a safe and reasonable decision with respect to committing landing craft and amphibious vehicles. The modified surf limit (MSL) is the MAXIMUM surf that should be attempted for routine operations. If the MSI exceeds the MSL for the craft or vehicle, the landing is not feasible without increasing the casualty rate. If the MSI is less than the MSL of the craft, the landing is feasible. The modification tables required to complete the calculations are located in chapter 11 of the COMNAVSURFPAC/COMNAVSURFLANTINST 3840.1, *COMNAVSURFPAC/*COMNAVSURFLANTINST *Joint Surf Manual*.

LCAC Surf Information

MSI is not applicable to the LCAC. Limiting conditions for operating the LCAC in the surf zone is based on load size and significant breaker height only. Table 4-2 on page 4-16 provides the LCAC limits to be used for planning purposes. Combat cargo personnel requiring

detailed mission planning parameters should consult the LCAC SEAOPS Manual or contact the LCAC assault craft unit detachment OIC.

Table 4-2. LCAC Planning Limits.

LOAD	SIGNIFICANT BREAKER HEIGHT
75 tons overload 60 tons normal payload 45 tons reduced payload	0-4 feet 4-8 feet 8-12 feet

Surf Limits for Raiding Craft

The MSI is not used for judging the feasibility of conducting combat rubber raiding craft/rigid raiding craft operations. Rigid raiding craft operations should only be conducted in relatively benign surf conditions, where the significant save height is 1 foot or less.

Beach Nomenclature and Characteristics

Terminology

The **offshore area** is that area from the 5-fathom curve seaward.

The **inshore area** is that area from the 5-fathom curve to the mean low water mark.

The **foreshore area** is that area from the mean low water mark up to the beginning of the ordinary or summer berm.

The **backshore** is that area that comprises both ordinary-summer and storm-winter berms.

The **coastal terrain** is that area from the storm-winter berm inland.

The **berm** is a nearly horizontal portion of the beach or backshore having an abrupt fall and formed by deposition of material by wave action, marks the limit of ordinary tides.

The **scarp** is an almost perpendicular slope caused by wave action and erosion along the shore line.

Characteristics

The trafficability of the **submerged section** is critical especially during low tide conditions.

The trafficability of the **moist section of the tide zone** is kept by the normal wave action on that beach at high tide.

The **dry section** includes berm and backshore, soft, hard, etc.

The areas in **back of the beach** (dunes, swamps, hills, mangroves, rocks, etc.).

Beach and Surf Hydrographics

The planning and execution of surfaceborne operations require combat cargo personnel to understand the effects of surf and hydrographic conditions. Studies of both features must be conducted because the surf on a given beach depends not only upon beach exposure, but also upon the underwater topography. Furthermore, the profile of sandy and gravel beaches is constantly altered by wave action. These features can have a profound affect on operations. The following paragraphs provide the information necessary to understand the beach and surf considerations used in planning and executing a surfaceborne operation.

Waves, Seas, and Swells

Waves are formed by wind, earthquakes, tides, the contour of the sea bottom, and the curve of the shoreline.

Terminology

The **crest** is the peak or upper limit of an individual wave, while the trough is the horizontal almost flat area between crests.

The **wave height** is the vertical distance from the crest to the preceding trough.

The **wave length** is the horizontal distance from crest to crest.

The **wave period** is the time it takes a wavelength to pass a given point.

Waves and the Shore

Shallow Water

Shallow water modifies and changes a wave, bending the wave front to approximate the shape of underwater contours. This is commonly known as refraction.

The water depth controls the velocity of the wave. Shallow water slows a wave resulting in waves striking nearly parallel to a shore.

The energy of a wave is concentrated in headlands where waves converge. Energy is spread out in bays where the waves are elongated.

Breakers

When the wave moves into water shallower than half the wavelength, the wave height will increase while the wavelength decreases causing breakers. At a water depth of 1.3 times the wave height, the water supply is reduced and the wave breaks. The three types of breakers are spilling breakers, plunging breakers, and surging breakers.

Spilling breakers normally occur on flat, mild and gentle beach gradients or slopes and to a lesser extent on moderate gradients. The crest slides down the face of the wave forming foam, giving a very gradual release of energy over a wide area. This type of breaker is preferred for conducting a surfaceborne operation.

Plunging breakers occur on steep gradients and to a lesser extent on moderate gradients. The crest plunges over into the preceding trough with a sudden release of energy in a narrow area. This condition is less preferred for conducting a surfaceborne operation.

Surging breakers occur on steep gradients. The backwash is very strong because of the steep slope. The wave builds like a plunging breaker but the sudden backwash stops the plunging and the breaker explodes onto the beach.

Effects of Breakers on Landing Craft

Breaker Height

High waves can swamp a craft by either plow in of the bow or when the wave breaks on the stern when landing or retracting from the beach.

Breaker Angle

Off-angle breakers can make it difficult for craft to remain on course or may result in breaching of the craft once it has landed.

Breaker Period

The interval at which the craft encounters breaking waves. Subjected to continuous impact resulting in loosing control of the craft, in drifting from the boat lane or correct beach, broaching.

Beach Gradient

The average bottom slope from the offshore area to the inshore area is called the beach gradient. The numbers refer to the rise-to-run ratio of the beach. For example, a steep gradient has a 1-foot rise in level every 15 feet of beach run. A gentle gradient is preferred for surfaceborne operations. Landing craft as well as LSTs have a keel slope of 1:45. This slope falls right in the middle of the gentle gradient. The five types of beach gradients follow:

SLOPE	RATIO
1 Steep	More than 1:15
2 Moderate	1:15 to 1:30
3 Gentle	1:30 to 1:60
4 Mild	1:60 to 1:120
5 Flat	Less than 1:120

Seas

Seas are generated by the wind, travel in the same approximate direction as the wind, and seas are generated within an area called the fetch. Within the fetch, the wind generating the seas has a constant direction and speed. The longer the wind duration and the greater the wind velocity, the greater the wave height.

Swell Action

Swells are waves that leave the fetch. They do not need local winds to sustain them. The crests of swells become lower and more rounded. Swells move in trains or groups of similar period and height. Seas and swells exist together. They can reinforce (crest meets crest) each other or cancel (crest meets trough) each other.

Tides

Combat cargo personnel must be familiar with the three types of tides and other tide related definitions. It is important to note that the majority of the Navy's charts are based on mean low water.

Semi-diurnal (semi-daily) tides are found on the East Coast of the United States. They consist of 2 low tides and 2 high tides in a 24-hour period (high-low-high-low).

Diurnal (daily) tides are found in the West Pacific and consist of 1 low tide and 1 high tide in a 24-hour period.

Mixed tides, are low and high tides. They are not divided equally in a 24-hour period by their intensity, however, they have a high tide inequality during a 24-hour period with consistent low tide levels. Mixed tides are found on the West Coast of the United States and Mid Pacific areas.

Definitions

The **high water** is the high level of a single tide.

The **low water** is the low level of a single tide.

The **mean high water** is the average of high tides.

The **mean low water** is the average of low tides.

The **range** is the vertical distance between high and low tide levels.

The **period** is the time for one complete tide cycle.

Sandbars

Sandbars are obstacles that parallel the majority of sand beaches. In some places they occur only during the season of largest waves, but elsewhere they persist throughout the year. Longitudinally the bars may be continuous for miles, but are likely to be discontinuous, being developed off some portions of a beach and not off others. The breaks in the bars can be detected from the air from the breaker pattern.

In some very sandy areas, a series of bars extends for miles out to sea and the outer ones attain depths far too great to interfere with surface-borne operations. However, the typical depth of the longshore bar ranges from about 3 to 15 feet below mean low water.

These offshore bars, particularly the shallower ones, are a serious menace to landings. Landing craft are often "hung" on the crest of the bars and a considerable time interval may elapse before they are able to cross.

Reefs, Shoals, and Currents

These environmental conditions can also have a dramatic affect on a waterborne landing. The following subparagraphs define each of these potential obstacles and clearly highlight their importance to operations planners.

Fringing Reefs

Fringing reefs are coral reefs attached to the land. The width may vary from a few feet to more than a mile. An inshore channel may be present on fringing reefs.

Barrier Reefs

Barrier reefs lie offshore and are separated from the land by a body of water called the lagoon. If the ship or landing craft operating areas can be established inside the reef, more stable sea conditions and anchorages will be assured.

Shoals

Uplifting seabed earthquakes form rock reefs. This may expose a rocky ledge or ridge offshore.

Offshore Currents

Offshore currents are found outside the surf zone. These currents are related to the distribution of density in the ocean and the effect of the winds. Examples are the Gulf Stream off the American East Coast and the Kuroshio off the coast of Japan. Currents of this type are constant for long periods, although they may vary in velocity and direction at different seasons of the year.

Longshore Currents

Longshore currents are found within the surf zone. Longshore or littoral currents flow parallel to the shoreline inside the breakers and are most commonly found along straight beaches. They are caused by waves breaking at an angle with the beach. Their velocity increases with increasing breaker height, with increasing angle of the breaker with the beach, and with steeper beach slopes. (Note: A breaker arriving parallel to the beach has an angle of 0 degrees to the beach.) The longshore currents are predictable but the accuracy of the forecast will depend upon the accuracy of the wave forecast on which it is based.

Rip Currents

Rip currents are caused by the waves piling water against the coast. This water flows along shore until it is deflected seaward by bottom irregularities or until it meets another current and flows out through the breakers. Once feeder and rip currents have formed, they cut troughs in the sand and remain fairly constant in position until the wave conditions change.

Land Fast Ice

Land fast ice creates several problems such as—

- The ability of landing craft to properly beach, lower their ramps, discharge their cargo while holding their position.
- The inability of LF troops to cross the ice quickly and safely.
- Ice near the shore is likely to collapse under the weight of vehicles and support equipment.

Landing Craft Casualties

A **casualty** is any mishap by which a craft is put out of operation, either temporarily or permanently.

Swamping is caused by surf conditions spilling a large amount of water into a landing craft.

Hanging is when a landing craft is grounded on a sandbar, reef or shoal.

Broaching is when a beached landing craft is forced parallel to the beach (and further grounded) by surf action. This is the most dangerous of all landing craft casualties.

Plow-in is when the forward skirt of the LCAC collapses inward causing excessive yawing.

Salvage Operations

The mission of the salvage organization is to keep all boat lanes and beachheads clear of disabled assault craft so that movement to the beach is maintained. This mission is performed by the following organizations.

The boat group commander is responsible for all salvage operations from the beach to the LOD during the initial assault. After the initial assault,

the boat group commander becomes a traffic control officer and is relieved of all salvage duties by the beachmaster unit. Once the beachmaster unit is established ashore, it takes charge of all salvage operations from the water line to the 3-fathom mark and assumes the duties of the senior salvage officer.

The assistant boat group commander takes charge of all salvage operations from the LOD to the rendezvous area during the initial assault. After the departure of the last scheduled wave from the rendezvous area, the assistant boat group commander becomes the senior salvage officer afloat and reports to the beachmaster unit.

Salvage boat assets are defined as being either heavy or light. The heavy salvage boat assets consist of landing craft, mechanized-8 (LCM-8); lighter, amphibious resupply, cargo (LARC); or the assault amphibious vehicle, recovery (AAVR). Heavy salvage boat assets follow the scheduled waves to the beach and remain in the vicinity of the beach. The light salvage boat assets consist of the landing craft personnel (large) (LCPL).